Comments and supporting documentation of NCASI and Arcadis regarding the use of bioaccumulation factors by EPA in deriving the 2015 National Recommended Human Health-based Water Quality Criteria.

Brief Summary: USEPA's revised criteria are derived using substance-specific bioaccumulation factors (BAFs) whereas the pre-2015 criteria were based on bioconcentration factors (BCFs). While a transition from BCFs to BAFs is consistent with accepted scientific consensus, the methodology USEPA used is not applicable to the waters of many States because it relies too heavily on models based on accumulation of polychlorinated biphenyls (PCBs) in the Great Lakes. PCBs are not representative of most of the substances for which criteria were revised, and USEPA has consistently stated that the Great Lakes are unique in their size, food web, temperature, historical pollutant loading and many other factors. States should evaluate whether USEPA's BAFs are appropriate for their waters.

Extended Summary: To estimate the accumulation of chemicals in fish and shellfish USEPA's 2015 National HHWQC use bioaccumulation factors (BAFs) rather than bioconcentration factors (BCFs). Theoretically, BCFs account for uptake from just water, whereas BAFs account for uptake from all pathways (e.g., water, diet, and sediment). The switch from BCFs to BAFs is consistent with the consensus in the scientific community that accumulation of most chemicals can be better predicted by accounting for uptake from all exposure pathways rather than just from water. The complicating factor with BAFs is that they depend upon water body specific characteristics such as the food web. Food webs can vary greatly between waters and so too can BAFs. To estimate National BAFs for the 2015 HHWQC, USEPA used a methodology that relies heavily on a model of PCB accumulation in the Great Lakes. USEPA stated repeatedly when discussing the need for Great Lakes Initiative in the 1990's, that the Great Lakes represent a set of waters and food web so unique that they need their own unique criteria. Thus, it is unclear whether a bioaccumulation model based on the Great Lakes is applicable to all waters in the United States and whether all the assumptions made by USEPA when developing National BAFs are appropriate. States should review the BAF methodology and USEPA's application of that methodology to determine the applicability to State-specific waters and food webs.

Technical Comments

To estimate the bioaccumulation of substances from surface water into fish and shellfish, USEPA developed and used methods and models detailed in their January 2016 supplemental information for development of national BAFs (USEPA 2016b). USEPA's process has an expressed preference for basing HHWQC on BAFs rather than bioconcentration factors (BCFs) because BAFs account for exposure of fish and shellfish from all exposure pathways (e.g., water, diet, sediment) while BCFs account for exposure from only water.

For most compounds[1], the USEPA methodology involves estimating a baseline BAF (i.e. a BAF based on the dissolved fraction and adjusted for lipid concentration) based on field or laboratory studies if available. When measured BAFs are available USEPA's procedure uses those to estimate bioaccumulation. When measured BAFs are not available USEPA estimates BAFs by multiplying either measured or modeled BCFs by a food chain multiplier (FCM). The FCM is intended to account for exposure of fish and shellfish from the non-water exposure pathways. Exceptions to this process include inorganic compounds that are not expected to biomagnify, ionized organic compounds, organic

[1] BCFs, and not BAFs, were developed and used to derive the proposed HHWQC for some compounds.

compounds with log K_{ow} of less than 4, and organic compounds that are highly metabolized. For compounds that fall into any of these four categories, USEPA's procedure suggests using a field measured BAF and, if such is not available, a laboratory derived BCF.

A more thorough evaluation of the USEPA methodology as it was applied by FDEP when developing Florida-specific HHWQC is included in Attachment E. Attachment F provides a review of USEPA's application of the methodology when deriving National BAFs for the 12 polycyclic aromatic hydrocarbons (PAH) for which USEPA updated HHWQC in 2015. The remainder of this section provides brief summaries of the key technical issues discussed in more detail in the two attachments referred to above.

Key Technical Issues Associated with USEPA's Application of the BAF Methodology

For compounds that do not have measured BAFs, a key step of USEPA's process for deriving a baseline BAF is multiplying a BCF by a FCM. USEPA's guidance lists certain characteristics of a compound that preclude the application of a FCM. One of those characteristics is "high metabolism", which is how USEPA classified PAHs. However, for PAHs, USEPA failed to correctly account for high metabolic transformation rates and multiplied laboratory BCFs by FCMs, which is not consistent with its guidance for highly metabolized compounds (see Attachments E and F). This report does not present a comprehensive review of USEPA's derivation of BAFs for all 94 compounds. Therefore, it is not known whether USEPA's deviation from its methodology is limited to PAH or occurs for other compounds as well. The findings for PAH may be indicative of deviations of other compounds from USEPA's methodology that should be investigated by States before adopting the BAFs used by USEPA to derive the 2015 national HHWQC.

USEPA's BAF derivation process includes establishing something USEPA refers to as a Baseline BAF. A Baseline BAF is expressed on a 100% lipid basis and assumes that all of a compound is dissolved in water (i.e., none of the compound in the water column is bound to organic carbon, so all of the compound is available to be accumulated). Baseline BAFs are supposed to be calculated based on the study-specific measurements of the freely dissolved fraction of a chemical during the experiment. Most studies reporting BCFs do not provide information on the fraction of a compound dissolved in the water column versus the fraction sorbed to organic carbon suspended in the water column. To estimate the fraction dissolved in the water column, USEPA needed to make assumptions about how much organic carbon was present in the experiments reporting BCFs. USEPA assumed all of those experiments had organic carbon equal to the median measured in United States surface waters. However, many BCF studies used filtered water. Such water will likely have a lower organic carbon concentration than that assumed by USEPA. When an organic carbon concentration more representative of filtered water is used to derive Baseline BAFs, the baseline BAFs decrease.

Finally, the USEPA database includes invertebrate species (e.g., the water flea (Daphnia magna), an amphipod (Pontoporeia hoyi), and a mayfly (Hexagenia limbata)) that are not representative of shellfish consumed by the general population. Whether the accumulation of compounds in typically consumed'shellfish is well represented by BAFs and BCFs from amphipods, mayflies and water fleas is unknown. What is known is that these organisms are very different from those that are regularly consumed. Until it has been shown that their BAFs and BCFs are representative of regularly consumed species, States should consider whether it might be best to exclude them when estimating the BAFs and

BCFs of regularly consumed shellfish species, particularly for compounds for which such species have a strong influence on the Baseline BAF.

Applicability to State-Specific Criteria

The USEPA Baseline BAFs should be converted to State-specific BAFs using State-specific assumptions about the concentration of dissolved organic carbon (DOC) and particulate organic carbon (POC) in surface water, parameters used to calculate the freely dissolved fraction in surface waters, and State-specific assumptions for the lipid content in each trophic level. Furthermore, review of the applicability of national FCMs to State-specific surface waters and food webs revealed numerous reasons to believe the national default assumptions used by USEPA to derive national FCMs are unlikely to be representative of State-specific conditions.

First, the model used by USEPA to derive national FCMs is based on and calibrated for a Great Lakes food web using PCB data. A State-specific food web may have substantially different inputs and structure and could result in a very different FCMs. As an example, Florida waters do not support alewives, smelt, or salmonids and the lipid content of many fresh water species appears to be lower in Florida than in the Great Lakes (Attachment E). While it is unknown whether food webs more representative of State-specific surface waters will have higher or lower FCMs than those derived for the Great Lakes, the components and structure may be very different.

Second, USEPA's model assumes that surface waters have had a long history of loading of compounds followed by a relatively recent reduction in such loading (such as PCBs in the Great Lakes and Hudson River in the 1980's and 1990's). That scenario of high historic loading leads to a high proportion of a compound in sediments compared to conditions closer to equilibrium. The effect of that high proportion of a compound in sediments is to increase FCMs. FCMs decrease substantially when compound loadings expected to be representative of most waters in the United States and Florida are employed in the FCM model.

Third, USEPA uses FCMs developed using the assumption of no metabolic transformation to derive HHWQC for many compounds that are likely to be metabolized to some degree by fish or shellfish or both. The potential effect on FCMs of incorporating metabolism was investigated for pentachlorophenol, heptachlor, and 1,3-dichlorobenzene. When the compound-specific metabolic transformation rate constants were incorporated into the FCM model, the FCMs dropped substantially for all three chemicals (Attachment E).

Fourth, the temperature used in the USEPA model is much cooler than might be expected in State-specific waters. Use of a higher temperature in the FCM model increases FCMs because the higher temperature results in an increase in dietary intake in the model. Because the model assumes no metabolic transformation, the increased dietary intake is not balanced by what one might expect to be an increased rate of metabolic transformation as temperature increases.

Fifth, when setting State-specific HHWQC, States may wish to consider modifying one other assumption made by USEPA in the application of the BAF methodology. USEPA's trophic level-specific BAFs are adjusted for the assumed lipid content of aquatic species in each trophic level (USEPA 2016b). The National BAFs are based on national data for each trophic level. When State-specific data are available

for the lipid content for species in each trophic level, States should consider using those data to derive State-specific BAFs for each trophic level.